AN ETIOLOGIC APPRAISAL OF HAND DERMATITIS

II. The Role of Soaps and Detergents as Primary Irritants*

JAMES J. JAMBOR, M.D.

In the foregoing study an etiologic appraisal of 57 cases of hand dermatitis was described, in which an attempt was made to determine what role soaps and synthetic detergents play as cutaneous sensitizers in the pathogenesis of hand dermatitis (1).

The present investigation was undertaken to ascertain the role played by soaps and detergents as primary irritants in the pathogenesis or aggravation of hand dermatitis. The phase of the study reported here was an attempt to reproduce experimentally one phase of the presumed irritant action of commercial soaps and detergents under controlled conditions and to employ objective methods to quantitate such induced change in the skin.

MATERIALS AND METHODS

The subjects, as in the previous study, were selected from the Outpatient Department of the Cincinnati General Hospital or referred to the hospital by the cooperative effort of local dermatologists from their private practices. The main criterion for selection of the subjects was that their dermatitis of the hands presumably was maintained or aggravated by the use of commercial soaps or synthetic detergents. Patients were also chosen on the basis of the fact that they had a symmetrical dermatitis affecting both hands. Since the previous study (1) had demonstrated a high incidence of concomitant and complicating dermatoses in cases of alleged "detergent eczema," and since we were primarily interested in eliciting irritation, we felt that this selection was not too broad for the purposes of the study. The subjects were hospitalized for the period of their investigation, in order to assure uniformity of environment and constant observation. In the course of the investigation, closed 48 hour patch tests were performed with personal contactants, a group of 42 common substances and freshly prepared, one per cent aqueous solutions of nine different commercial soaps and detergents. The standard test substances were as follows:

0.1%	Silver Nitrate		Chinawood Oil
25%	Oil of Clove	5%	Cobalt Nitrate
5%	Copper Sulfate	1%	Eucalyptus Oil
5%	Formalin	10%	Kerosene
0.1%	Mercuric Chloride	5%	Nickel Sulfate
	Peanut Oil	2%	Phenol
0.5%	Potassium Dichromate	1%	Resorcin
50%	Toluene	5%	Turpentine
	Linseed Oil		Distilled Water

* From the Department of Dermatology and Syphilology, College of Medicine, University of Cincinnati, Dr. Leon Goldman, Director.

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5% Crude Coal Tar	5% Ammoniated Mercury
2% Paraphenylenediamine	Lanolin
Nickel Coin	Lucite
Cellulose Acetate	1:5000 Poison Ivy Extract
Merthiolate Tincture	Aluminum Foil
Copper Foil	2% Chromic Chloride
25% Potassium Iodide	5% Benzocaine
2% FD and C Orange 1	2% FD and C Orange 2
2% FD and C Yellow 3	2% FD and C Yellow 4
2% FD and C Yellow 5	2% FD and C Yellow 6
2% FD and C Red 1	2% FD and C Red 2
2% FD and C Red 32	2% FD and C Red 4

1% Solutions of nine soaps and synthetic detergents.

An immersion technic was used to investigate the irritant action of soaps and synthetic detergents. To isolate the effect of the surface-active agent or soap as the inciting factor in this study, the simultaneous symmetrical paired comparison method was employed, the right hand being immersed in a constant temperature bath (see Fig. 1A) containing an 0.5%* concentration of the soap or detergent solution at 105°F. for one-half hour, while the left hand control was immersed in a solution of tap water of the same temperature. The immersions were performed on four successive days, employing in sequence: A, a fine fabric soap (pH 10.0); B, a fine fabric, synthetic detergent (pH 6.7); C, an all-purpose ("built") laundry soap (pH 9.9); and D, an all-purpose ("built") synthetic detergent (pH 9.8). The pH measurements were made on solutions at 105°F. Observations were carried out on the hands immediately post-immersion, at 15 minute intervals for the first hour, and at subsequent intervals of 1, 2, 4, 6 and 24 hours.

The hands were examined with a Spencer binocular dissecting microscope (see Fig. 1B), and assigned a score on the basis of erythema and scaling. The absence of erythema or scaling was assigned a score value of 10; slight erythema or scaling a score of 9, etc., with the boundary line of incipient but frank dermatitis having a value of five. Fissuring, slight exudation, moderate and marked exudation or bleeding were given the values of 3, 2, 1 and zero, respectively. The investigator was checked in his readings by an independent observer, and the absolute score always was within the range of a plus or minus one. The difference in one unit in clinical scoring was not regarded as significant. In the comparison of the test hand and the control hand there was always agreement as to which hand received the higher score.

The pH of the cutaneous surface was determined for both the dorsal and volar surfaces with the Beckman Calomel-electrode pH-meter (see Fig. 1C), using as the conducting electrolyte, several drops of physiologic saline which had been allowed to come into equilibrium with the skin surface.

An attempt was made to measure quantitatively the degree of erythema with the use of an erythrometer (see Fig. 1D). The instrument consisted of a platform to maintain constant geometrical relationships with both the source of illumination and the photoelectric cell. Readings were taken on the photometer of the

* The usual concentration employed for dishwashing is 0.3 to 0.5%.

reflected light from both the palm and dorsum, with the reflected light passing through either a red filter or a green filter. It was believed that the difference in readings between the red and green filtered reflected light would give a measure of "redness" by compensating for any changes in the reflectance of the skin.

Colored photographs of the hands were taken serially at the above stated intervals when the scoring and other measurements were made. The rolls of film were developed simultaneously to eliminate changes in color values due to variations in processing of film, and to permit comparisons between the appearance of the hands at different moments in the study.

There were 22 subjects evaluated in this series, 12 of whom were women. Table I shows the distribution by occupation.

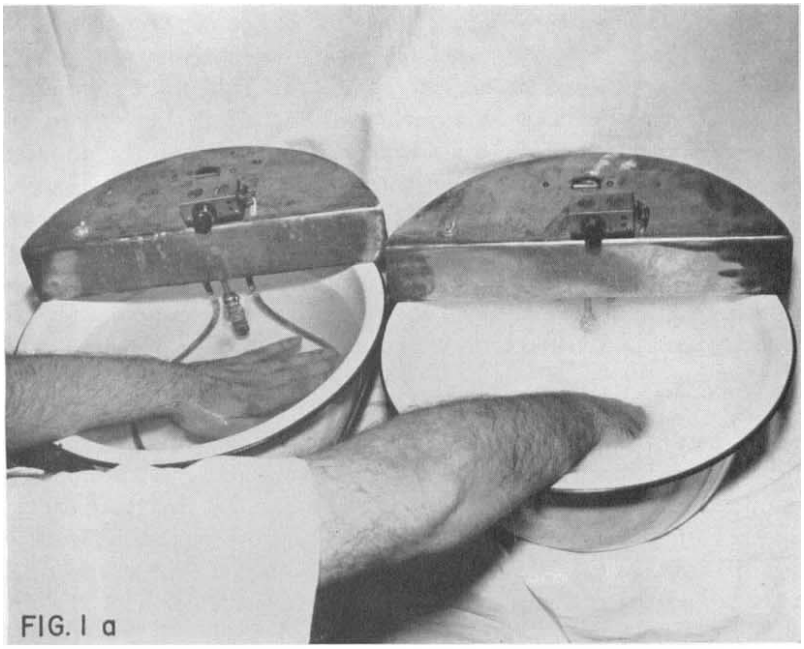
OBSERVATIONS

Table II shows the results of the etiologic investigation which included the patch tests described as well as mycologic and bacteriologic studies, histopathologic examination of excised tissue and clinical usage test involving exposure to the suspected etiologic agents, to support or disprove the significance of the patch test findings. In the case of a convincing history of exposure to a primary irritant we tested the patients to nonirritating concentrations of the primary irritant only.

Among the 22 subjects, signs of irritation and deterioration of the cutaneous condition developed in only one case after the test immersion in each of the four test substances as well as immersion in the tap water control. In this subject the degree of increased irritation and deterioration was relatively small and was the same in both the hand exposed to the soaps and the synthetic detergents as well as the control hand which was immersed in tap water. This subject dated the onset of her dermatitis from the use of an undiluted bleaching solution, and on admission appeared to have an infected chemical burn.

The other 21 subjects showed no evidence of persistent irritation ascribable to the test detergents or soaps, and both test and control scores showed a remarkable tendency to follow an identical pattern. The findings on one representative subject are presented (see Fig. 2, 3, 4, 5, and 6). Figure 2 demonstrates the essential lack of change pre- and post-immersion in the test and control hands.

The subject was a 55 year old white male with a history of dermatitis of the hands and feet of 17 years' duration. The dermatitis started on his hands, and involved his feet several months later. The primary lesions were intensely pruritic vesicles and bullae, located on both dorsal and ventral surfaces of his hands and feet. At the time of admission these were no longer in evidence but had been followed by marked erythema, edema, hyperkeratosis, deep fissuring and scaling. The subject first noted the lesions when he worked in a chrome-plating operation. He also indicated that as soon as he entered the door of this plating establishment he would have difficulty breathing, developed generalized pruritus and facial edema. He gave up this work and became a dishwasher. Most of the 17 years since the onset were spent in various Veterans' Administration hospitals. He would improve while he was on bed rest, but as soon as he was discharged to work



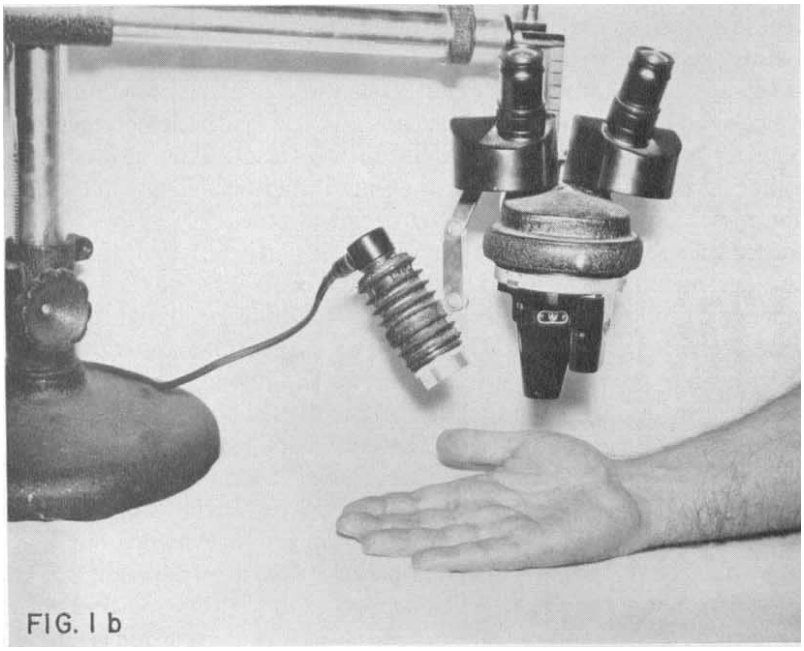


FIG. 1. a. Constant temperature immersion baths for test solution (right hand) and tap water control (left hand). b. Binocular dissecting microscope used for visualizing cutaneous surfaces in clinical scoring, pre- and post-immersion.

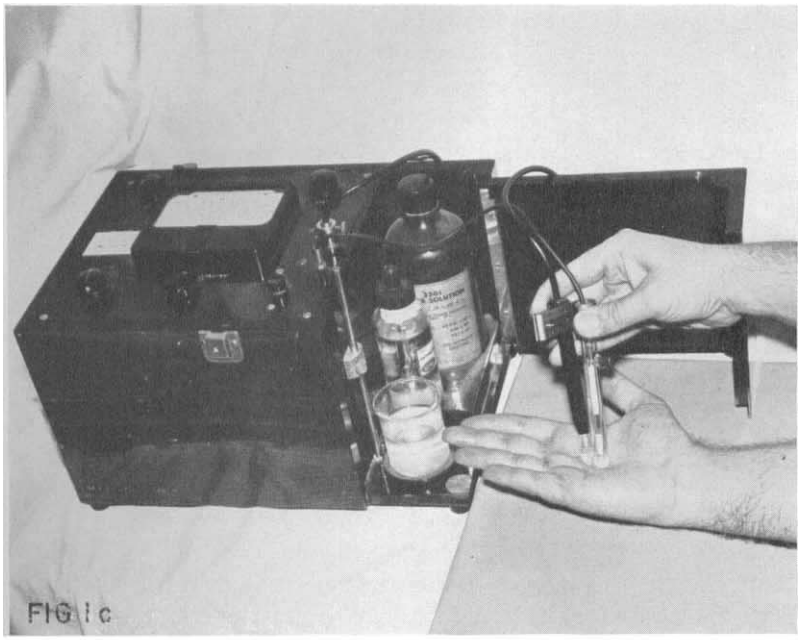


FIG. 1. c. Beckman Calomel electrode pH-meter employed for determining cutaneous surface pH, pre- and post-immersion. d. "Erythrometer" used for determining degree of redness pre- and post-immersion.

TABLE I

Distribution by occupation

Housewives	7
Waiters and dishwashers	4
Ward maid in hospital	1
Machinists	2
Foundry worker	1
Locomotive washer	1
Domestics	3
Student	1
Painter	1
Truck driver	1
Total	22

he would have a flare of the dermatitis on both hands and feet. This had been attributed to his work with cleaning agents, to various psychosomatic difficulties, and to fungous infections.

Patch testing revealed a marked hypersensitivity to hexavalent chromium, to trivalent chromium, to chrome-tanned leather from his shoes and belt . . . but not to vegetable-tanned leather. Removal of chromates and chrome-tanned leather from his environment was followed by a subsidence of his dermatitis. The detailed examination of this patient's reactivity to chromium compounds will be published in a separate report.

pH determinations

The return of the skin following immersion to its normal pH, e.g., buffering action, appeared to depend upon several factors: the pH of the solution; the

TABLE II

Etiologic diagnoses

Psoriasis with menopausal hyperhidrosis	1
Avitaminosis A with contact dermatitis from hand lotion	1
Hypersensitivity to chrome-tanned leather and hexavalent chromate	2
Hypersensitivity to cutting oil	2
Lupus erythematosus and contact dermatitis from sulfur ointment	1
Oil folliculitis and turpentine burn	1
Erosio interdigitale blastomycetica	1
Neurotic excoriations with secondary infection	2
Stasis dermatitis with ids	1
Mycosis fungoides	1
Infected chemical burns from undiluted bleach	3
Contact dermatitis from tomato plant	1
Hyperhidrosis and recurrent vesicular eruption of palms and soles	1
Chronic pyoderma	1
Tinea pedis with ids	1
Atopic dermatitis	1
Nickel hypersensitivity	1

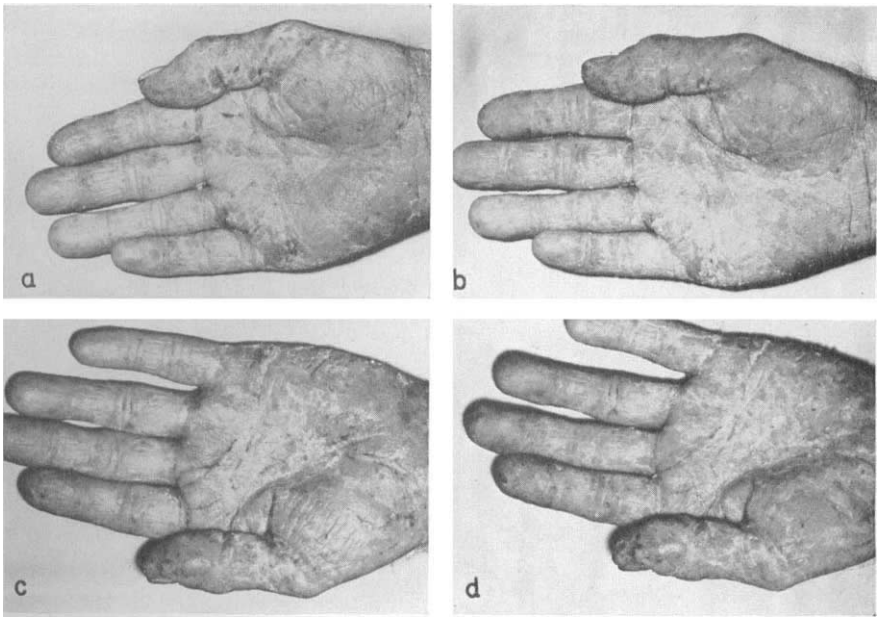


FIG. 2. a. Right palm of subject L. C. before immersion in test solution "A" (fine fabric soap). b. Right palm of subject L. C. following a 30 minute immersion in solution "A" (fine fabric soap). c. Left palm of subject L. C. before immersion in tap water control. d. Left palm of subject L. C. following a 30 minute immersion in tap water control.

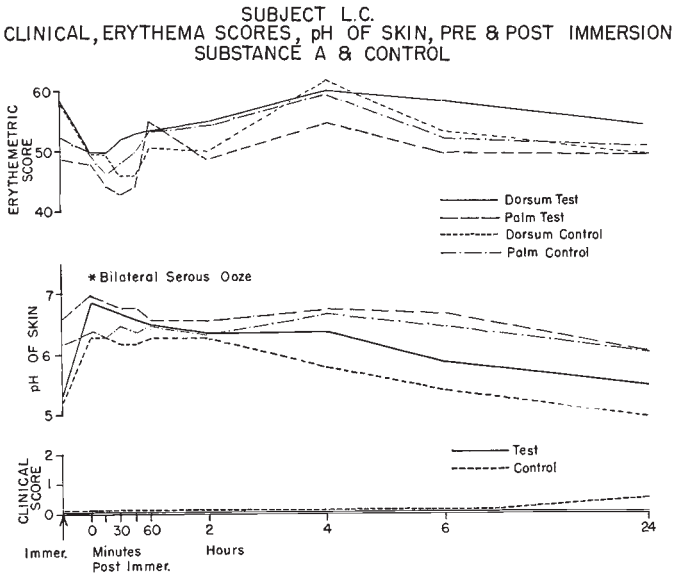


FIG. 3

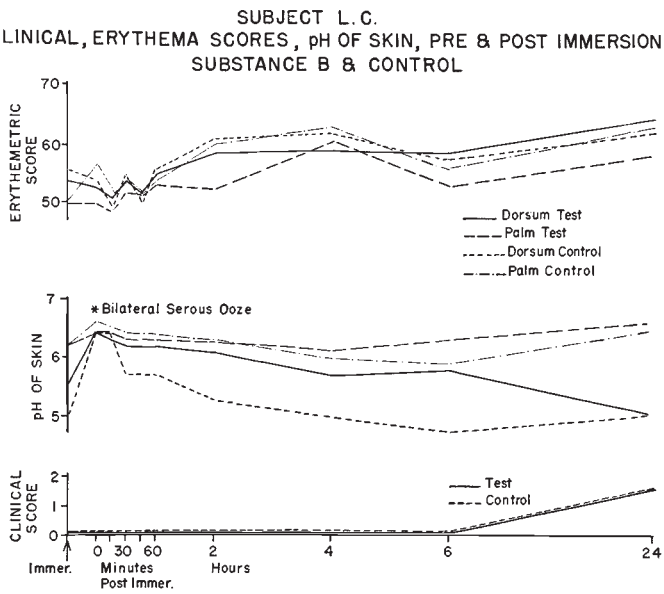


FIG. 4

amount of hyperkeratosis present; the hydration of the keratin; and the amount of sweating which the patient did. The pH of the immersion solutions were as follows: Substance A, 10.0; B, 6.7; C, 9.9; D, 9.8. It is to be noted that the tap water control was characteristically alkaline with a pH ranging from 7.9–8.9.

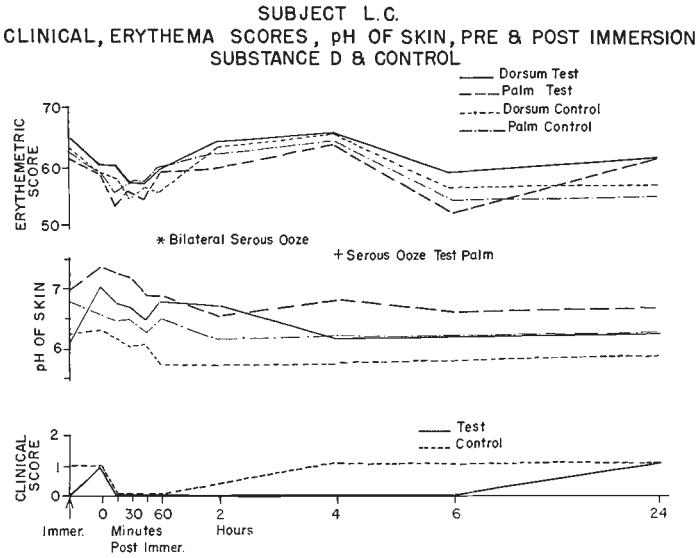


FIG. 5

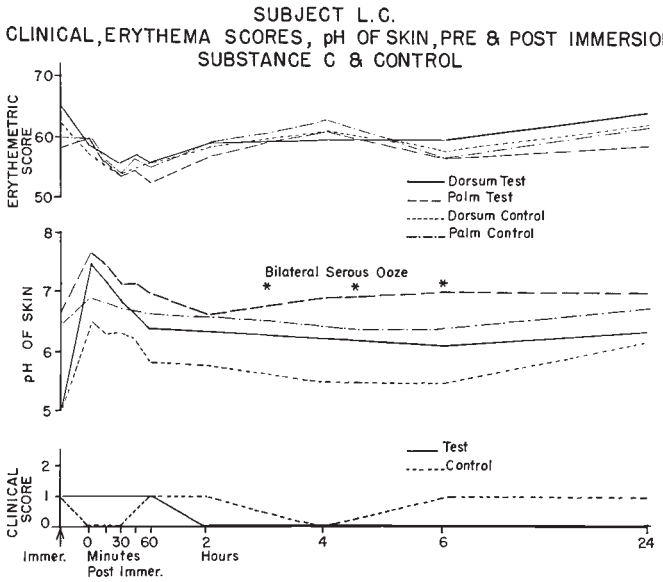


FIG. 6

Erythrometric determination

The attempts to quantitate redness were disappointing in that frequently the measured degree of erythema was less immediately after immersion than it was before immersion. In such instances, too, there was increased erythema observed clinically following immersion. It becomes apparent that since the readings were a function of the light reflectance of the entire cutaneous surface of the hand, that the amount of hyperkeratosis, its hydration, and the efficiency of reflection of its surface were the factors of prime importance in determining whether the readings showed an increase or decrease in "redness." Since the readings were a function of these factors, rather than that of the effect of heat and immersion, consistent readings were obtained only in those patients with slight or no hyperkeratosis. However, the readings of the erythrometer showed a remarkable consistency in comparing the control hand and the test hand. No difference was noted between the control hand and the test hand when the erythrometer readings were compared.

Clinical scoring

In a total of six subjects there was, for a brief period following immersion, a decrease in the score of the test hand with one or more solutions which was greater than that seen in the control hand. In contrast, five subjects showed a decline in the score of the control hand greater than the decline in the test hand. In 11 subjects there was no difference in clinical score between the two hands following immersion in each of the four solutions.

It was observed that the degree of hydration of skin keratin was greater with soaps than with the synthetic detergents, and the degree of hydration and its duration, as observed with the skin microscope, paralleled the duration of alkalinity as determined by pH measurement.

An interesting and incidental observation was that sudden rises in the pH prompted the observer to re-examine the skin microscopically only to find small areas of fresh serous exudation which he had missed in prior examination.

Finally it was observed that those patients who had a normal or excessive sweat secretion neutralized the alkali more rapidly, tolerated the immersions better and returned to the pre-immersion state more rapidly than did those who had hyperkeratotic and scaling skin.

DISCUSSION

In this series of 22 subjects using the technic of passive single immersion for 30 min. at 105°F, persistent irritation was not elicited by detergents and soaps. It is altogether likely that the failure to elicit clinical reaction was due to the fact that *the immersions employed were not of sufficient duration and frequency.* This study did not include the simultaneous effect of mechanical irritation, and of other substances present in dishwater. It is likely that these factors also play some role in the pathogenesis and aggravation of hand dermatitis. These factors are under investigation at the present time.

SUMMARY

1. A detailed technic is described for the study of the irritant potential of soaps and synthetic detergents.

2. Under the limited conditions of the experiment (single, short, passive immersion) it was not possible to produce evidence of persistent irritation from the soaps and synthetic detergents used.

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